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The effect of some environmental factors on the pattern of distribution of soil Collembola in a coniferous woodland

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With 4 figures in the text

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Contents

1 Introduction

Earlier work (POOLE 1961), carried out in a Douglas fir plantation, produced evidence to show that the more common Collembola were aggregated and that more than one species was aggregated in the same place. Since the depth of the organic layer and also its moisture content were shown to influence the numbers of the common species it seemed probable that the positions of the aggregations were determined in the main by environmental factors.

In the present study a systematic method of sampling was used in the same forest area in order to determine whether the pattern of aggregations could be related to the position of the trees in the plantation, since it appeared that the trees themselves might affect the moisture content and depth of the organic layer with which the Collembola were correlated. It was hoped that a series of transects taken from the bases of the trees might reveal some constant relationship between the numbers of Collembola and the distance from the tree. In addition, the relationships between the numbers of Collembola and the moisture content, depth and weight of the organic layer were investigated to find whether they were similar to those demonstrated in the previous work when a different method of sampling was employed.

There had been very little other work on the patterns of distribution of soil Collembola and their relation to environmental factors. GLASGOW (1939) correlated the numbers of soil Onychiuridae with the physical characteristics of the soil but with inconclusive results and MACFADYEN (1952) showed, that in a *Molinia* fen, whilst the Collembola were aggre-

gated, their distribution within a plant type was uniform, the variation between remote cores being no greater than between adjacent cores.

2 Methods

2.1 Choice of habitat

This work was carried out in Waen Wen plantation which is approximately three miles (five kilometres) from Bangor, North Wales (Grid reference 23/580690) at an altitude varying between 225 and 290 feet (68 and 90 metres). The plantation was selected because it was a pure stand of twenty-five year old Douglas fir (*Pseudotsuga Douglasii* CARRIÈRE) trees with a complete canopy and no ground flora; the average height of the trees was 45 feet ($\pm$ 1.6) ie 13.7 metres. The forest floor between the trees had a very even slope.

The area has been adequately described by O'CONNOR (1957) in his work on the Enchytraeidae of the area and was the same as that employed in earlier work on the food (POOLE 1959) and ecology (POOLE 1961) of soil Collembola.

2.2 Method of extraction

A modified Tullgren funnel was used for the extraction of the Collembola from the soil. The apparatus resembled that described by MACFADYEN (1953) but employed the split-funnel principle introduced by P. W. MURPHY (1955). The Collembola were collected in thirty-six stainless steel tubes forming corers of 5 cm diameter and 5 cm depth. The undisturbed cores were inverted when placed in the extraction apparatus so that the original upper surface was nearest the funnel and collecting tube (see MACFADYEN 1953).

2.3 Method of sampling

The trees in the wood were planted, evenly spaced, in equidistant parallel rows. This resulted in each tree standing at the corner of a diamond-shaped area (henceforth referred to as a 'square') as illustrated in figure 1. The squares chosen for transects were selected from an experimental

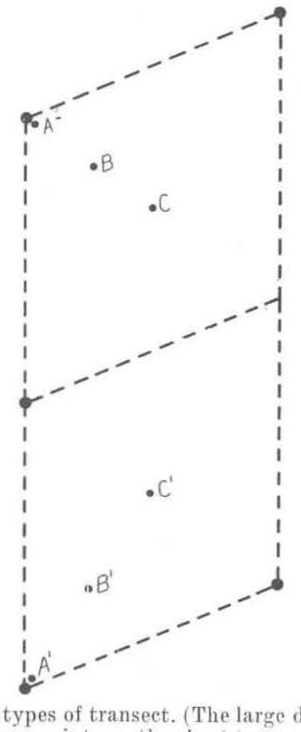

Fig. 1. Diagram to show the two types of transect. (The large dots at the corners of the 'squares' represent standing trees. A, B, C are points on the short transect and A', B', C' are points on the long transect.)

area of 520 squares (Study area B of O'CONNOR 1957 and POOLE 1961); unfortunately, it was not possible to take them at random as, owing to extensive thinning, only a limited number of squares contained even three standing trees, but the transects were evenly spaced throughout the area.

Twelve transects were taken from the bases of the trees to the centres of the appropriate squares. Each transect comprised three points, core A being taken near the base of the tree, core B halfway along the transect and core C at the centre of the square (see figure 1). Since the areas referred to as squares were, in fact, diamond shaped, it was possible to take two types of transect differing in length, short transects of approximately 42inches (1.07 m) length (see figure 1, A, B, C) and long transects of approximately 60inches (1.52 m) length (see figure 1, A', B', C'). In order to eliminate any possible directional effect, three of the six long transects were taken in a south-easterly direction and three in a north-westerly direction and of the six short transects, three pointed south-west and three north-east. So that all the squares were comparable, only those which contained three standing trees were used and each transect was taken from the apex of the isosceles triangle formed by the trees (see figure 1).

The corers were placed in the soil so that the samples taken included the whole of the organic layer and, owing to the limited capacity of the extraction apparatus, this was not sub-divided into litter and humus to allow for the extraction of the maximum number of cores. It had been shown in previous work that most of the Collembola were found in the organic layer as a whole.

2.4 Data obtained from the cores

All the Collembola extracted from the cores were counted and identified and the depth, weight and moisture content of the organic layer of the soil were recorded. In addition, measurements were made of the moisture content of the underlying mineral soil.

For the purpose of statistical analysis, the collembolan data were transformed into logarithms of the number of individuals in the core plus one. This was necessary because the insects were aggregated resulting in a skewed distribution of the core totals about the mean (see POOLE 1961).

3 Results

3.1 Physical data

3.11 Evidence of gradients

In order to discover whether there were any consistent differences between the points on the transects, 't' tests were carried out. The results are given in Table 1, showing that position A had the lowest moisture contents for both the organic layer and the soil and also the shallowest organic layer.

Table 1.

Differences in the values of physical factors at different points on the transect

Physical factor	a) All transects together Values of "t" C—A	B—A	C—B	b) Short and Long Transects Type of Transects	Values of "t" C—A	B—A	C—B
Moisture content of organic layer	2.67*	2.46*	0.75	Short	3.18*	1.09	1.86
				Long	2.45	2.31	—0.23
Depth of organic layer	3.02*	1.75	1.59	Short	0.94	1.19	0.37
				Long	4.66**	2.37	1.72
Dry weight of organic layer	1.82	1.22	1.53	Short	0.62	0.48	0.74
				Long	2.89*	0.99	1.33
Moisture content of soil	3.01*	1.96	1.15	Short	1.39	0.83	0.16
				Long	1.88	2.07	1.14

a) Significant values of "t" ($n = 11$)
2.20 $p = 0.05$
3.11 $p = 0.01$
4.59 $p = 0.001$

b) Significant values of "t" ($n = 5$)
2.57 $p = 0.05$
4.03 $p = 0.01$
6.86 $p = 0.001$

The data for long and short transects were analysed independently and the results show that the driest organic layer was found at A in the short transects and the shallowest organic layer at A' in the long transects.

These results indicate the existence of a gradient in the depth, weight and moisture content of the organic layer from the base of the tree. The results are presented in the form of a diagram in figure 2 and it can be seen that the steepest part of the gradient is between the base of the tree (A) and the middle of the transect (B).

3.12 *Correlations between physical factors*

The correlation coefficients and the partial correlation coefficients for the physical factors were calculated (see Table 2) and the former show that the weights and depths of the organic

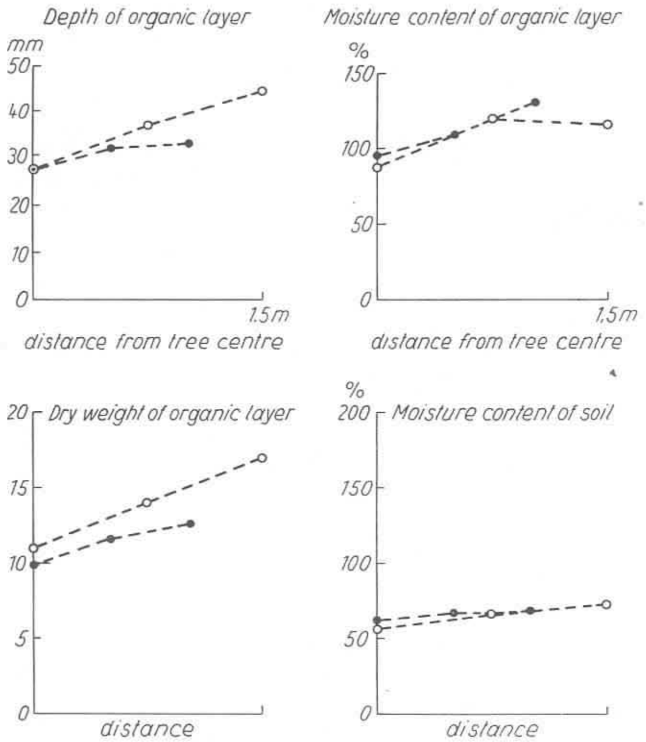

Fig. 2. The average values for the physical factors at different points on the long and short transects. [The abscissa represents the distance from the base of the tree and is 5 feet (1.5 m) in length.]

Table 2.
Correlation coefficients and partial correlation coefficients between different physical factors

Correlations			Partial Correlations	
Physical Factors		value of r	Constant factor	value of r
Moisture content of organic layer	Depth of organic layer	0.24	Weight of organic layer	0.62***
Moisture content of organic layer	Weight of organic layer	— 0.15	Depth of organic layer	— 0.59***
Weight of organic layer	Depth of organic layer	0.80***	Moisture content of organic layer	0.87***
	Significant values of r (n = 30)	0.35 0.45 0.55	p = 0.05 p = 0.01 p = 0.001	

layer were closely correlated and the latter revealed a positive relationship between the depth and moisture content of the organic layer when the weight was held constant; however, when the depth of the organic layer was held constant, the weight and moisture content were found to show a strong negative correlation. This shows that a deep organic layer has a higher moisture content than a shallow one; the reason for the inverse relationship between the weight and moisture content is probably due to the effect of mineral matter in the humus which, while increasing the weight, at the same time reduces the percentage moisture content owing to its poor water-holding capacity.

3.2 Collembola

3.21 Species composition and population structure

A total of 4,060 Collembola were recorded from this study, five species making up 90% of the total population. These were, in order of abundance, *Isotoma notabilis*, *Isotomurus plumosus*, *Megalothorax minimus*, *Friesea mirabilis* and *Tullbergia krausbaueri*. The more important statistical data for these species are recorded in Table 3. It should be noted that, numerically, *I. notabilis* represents more than half the number of Collembola recorded. The high relative variances (or variance: mean ratios) shown by the total number of Collembola and by the individual species are of interest since they imply an aggregated population. The 't' test was applied to the relative variances which were found to show a highly significant departure from random ($p < 0.001$). The fact that the collembolan totals were also aggregated suggests that more than one species had aggregations in the same place. If this were not so, aggregations of different species would tend to balance each other, resulting in a near random distribution of the Collembola as a whole, with a low relative variance. This supposition that more than one species of Collembola was aggregated in the same place was confirmed by calculating the correlation coefficients between the species (see Table 4).

Table 3.
Recorded figures for the Collembola

Species	Average per core.	Percentage of all Collembola	Thousands per sq. m.	Population variance	Relative Variance
Isotoma notabilis Schäffer	58.3	51.7	322	6578.0	126.9
Isotomurus plumosus Bagnall	22.4	19.8	124	1595.6	80.5
Friesea mirabilis (Tullberg) f. *reducta* Stach	5.0	4.5	28	30.7	6.8
Tullbergia krausbaueri (Börner)	4.8	4.3	27	44.6	10.3
Megalothorax minimus Willem	9.9	8.8	55	131.6	15.0
Other species	12.3	10.9	68	—	—
Totals....................	112.8	100.0	623	10489.3	93.0

Partial correlation coefficients were also calculated in order to discover whether or not the correlations between the species were caused by their common relationship with one of the measured physical factors. It can be seen from Table 4 that whilst the measured physical factors contributed to the correlations between the species, they do not appear to have represented the full explanation.

The results are also diagramatically represented in Table 5 where they are compared with those previously obtained from random sampling one year earlier in the same habitat (see Poole 1961). Factors contributing to the correlations are shown in brackets and a weak correlation ($0.1 > p > 0.05$) is represented by a broken line.

Table 4.
Correlation coefficients and partial correlation coefficients between the numbers of different species of Collembola

Correlations			Partial Correlations	
Collembolan species		Value of "r"	Constant factor	Value of "r"
I. notabilis	*Ir. plumosus*	0.54**	Depth of organic layer	0.38*
	"		Weight of organic layer	0.43*
	F. mirabilis	0.23		
	T. krausbaueri	— 0.04		
	M. minimus	0.58***	Depth of organic layer	0.34
Ir. plumosus	*F. mirabilis*	0.10		
	T. krausbaueri	— 0.07		
	M. minimus	0.07		
F. mirabilis	*T. krausbaueri*	0.85***	Moisture content of organic layer	0.82***
	M. minimus	0.52**	Depth of organic layer	0.34
T. krausbaueri	*M. minimus*	0.19		
	Significant values of r (n = 30)		0.35 p = 0.05 0.45 p = 0.01 0.55 p = 0.001	

Table 5.
A diagramatic representation of the correlations between different species of Collembola in this work and in previous random sampling data taken at the same time the previous year (POOLE 1961)

Transect Data

$$\textit{Ir. plumosus} \underset{\text{(Depth)}}{\longleftrightarrow} \textit{I. notabilis} \underset{\text{(Depth)}}{\longleftrightarrow} \textit{M. minimus} \underset{\text{(Depth)}}{\longleftrightarrow} \textit{F. mirabilis} \underset{\text{(Moisture)}}{\longleftrightarrow} \textit{T. krausbaueri}$$

Random Data

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I. notabilis ←————→ F. mirabilis ←——————————→ T. krausbaueri
     ↑         (Depth)     ↑ (Depth)    (Moisture)
     |        (Moisture)   | (Moisture)
     |                     ↓
     |—————————————— M. minimus
          (Depth)
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Note: Factors in brackets represent correlations which contribute to the relationship.

The results expressed in this way suggest that the correlations are between species with the most similar distribution in the soil profile. Although they are not exactly the same for the two sets of data, the agreement is close taking into account the facts that the pattern of sampling was different in the two cases and that the mineral soil was included in the data obtained from random sampling over a period of a month.

3.22 Evidence of gradients in species distribution

In order to discover whether gradients from the base of the tree to the centre of the square existed for the five commonest species of Collembola occurring in Waen Wen (*I. notabilis*, *Ir. plumosus*, *F. mirabilis*, *T. krausbaueri* and *M. minimus*), 't' tests were performed on the data and the results are shown in Table 6. This demonstrates that *I. notabilis* and *F. mirabilis* have significantly lower populations at the base of a tree than at the centre of the square (see Table 6a). When these data are broken down into long and short transects the results (see Table 6b) show that, in the short transects, the numbers of *I. notabilis* are significantly smaller at the base of the tree but, in the long transects, this species shows a

Table 6.
Differences in the numbers of Collembola at different points on the transects

Species of Collembola	a) All Transects together Values of "t" C—A	B—A	C—B	b) Short and Long transects Type of Transect	Values of "t" C—A	B—A	C—B
I. notabilis	5.16**	2.90 *	2.10	Short	2.69*	1.84	0.38
				Long	5.04**	2.46	3.58*
Ir. plumosus	1.01	1.50	0.10	Short	1.07	1.21	0.53
				Long	0.08	1.03	— 0.71
F. mirabilis	4.88**	2.17	1.56	Short	2.49	0.89	1.17
				Long	4.75**	2.17	0.92
T. krausbaueri	1.92	2.21*	0.73	Short	1.36	0.62	0.15
				Long	1.55	2.64*	— 0.71
M. minimus	1.66	1.17	0.32	Short	0.47	0.33	0.03
				Long	1.93	1.58	0.48

For significant values of "t" see Table 1.

Table 7.
Correlation coefficients and partial correlation coefficients between the different species of Collembola and physical factors

Species	Correlations Physical attribute of organic layer	Value of "r"	Partial Correlations Constant Factor	Value of "r"
	Depth	0.66***	Moisture content	0.63***
			Weight	0.61***
I. notabilis	Dry weight	0.40*	Moisture content	0.47*
			Depth	— 0.27
	Moisture content	0.30	Weight	0.40*
			Depth	0.19
	Depth	0.42*	Moisture content	0.42*
			Weight	0.08
Ir. plumosus	Dry weight	0.47**	Moisture content	0.49**
			Depth	0.26
	Moisture content	0.05	Weight	0.13
			Depth	0.07
	Depth	0.47**	Moisture content	0.41*
			Weight	0.45*
F. mirabilis	Dry weight	0.26	Moisture content	0.43*
			Depth	0.21
	Moisture content	0.56***	Weight	0.63***
			Depth	0.52**
	Depth	0.14	Moisture content	0.04
			Weight	0.25
T. krausbaueri	Dry weight	— 0.01	Moisture content	0.06
			Depth	— 0.21
	Moisture content	0.42*	Weight	0.42*
			Depth	0.40*
	Depth	0.58***	Moisture content	0.54**
			Weight	0.60***
M. minimus	Dry weight	0.29	Moisture content	0.38*
			Depth	0.34
	Moisture content	0.38*	Weight	0.45*
			Depth	0.30

Significant values of r (n = 30) 0.35 p = 0.05
0.45 p = 0.01
0.55 p = 0.001

well-defined gradient from low numbers at the base of the tree to high numbers as the centre of the square is approached; however, though *F. mirabilis* has low numbers at the base of the tree, there is no evidence for a gradient across the rest of the transect. This indicates that a definite gradient from the base of the tree towards the centre of the square is shown only by *I. notabilis* in the long transect.

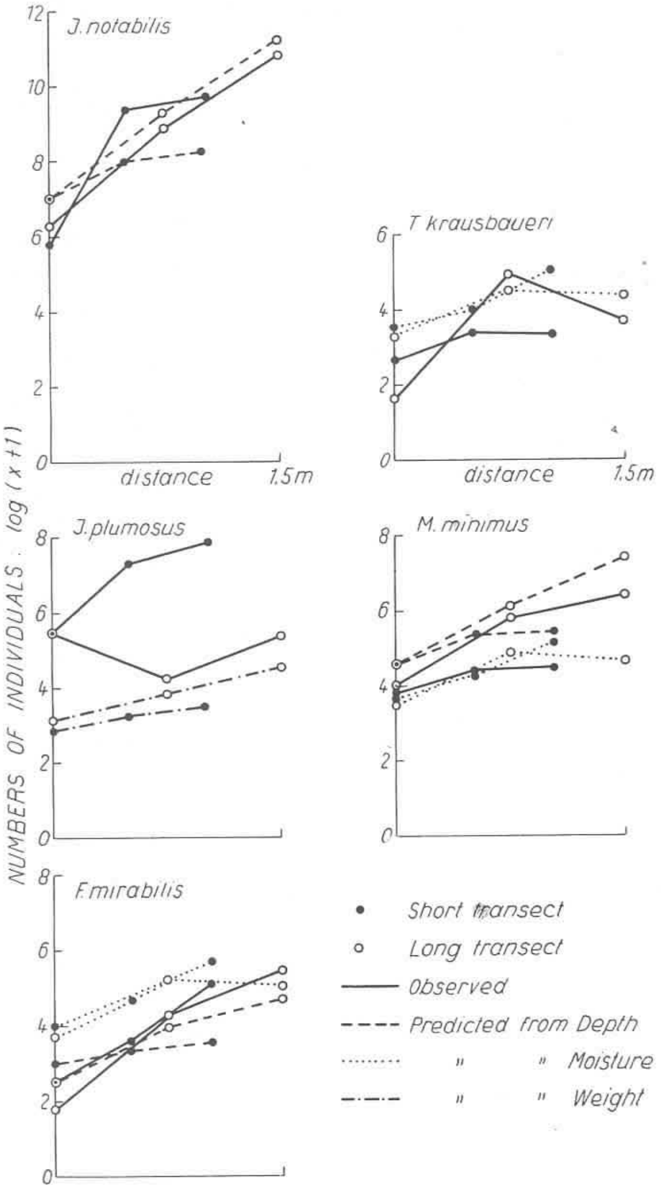

Fig. 3. The numbers of Collembola found at different points in the two types of transect and the values predicted from regressions with physical factors. (The abscissa represents the distance from the base of the tree and is 5 feet [1.5 m] in length).

3.23 Correlations between Collembola and physical factors

The results of the 't' tests carried out on the collembolan data showed that both the Collembola and the physical factors are influenced by the proximity and arrangement of the surrounding trees and to investigate whether the physical factors were influencing the distribution of the Collembola, the correlation coefficients between the Collembola and the environmental factors were calculated.

The results of these correlations and partial correlations are shown in Table 7 and reveal that correlations exist between the numbers of Collembola and the depth and moisture content of the organic layer for most species. Of the two factors, the depth of the organic layer appears to be the more generally important. In this respect the results are consistent with those obtained from random sampling in the same habitat at the same time of the previous year (see POOLE 1961), though they differ in detail. The most obvious of the differences is the independence of *Ir. plumosus* from the measured physical factors in the previous results and also from any relation to the numbers of other species of Collembola.

3.24 A comparison between the numbers of Collembola and the values of the physical factors in the two types of transect

It has been shown in the transects, that gradients exist for both Collembola and for some measured physical factors and also, that the Collembola are correlated with certain of these factors (see Table 6). Therefore it was important to show, whether, in fact, these physical factors were responsible for the observed distribution of the Collembola. This was done by calculating the regression parameters from which can be shown the expected numbers of Collembola for the observed values of the physical factors. Figure 3 graphically illustrates the observed numbers of Collembola and those calculated from the regression parameters; only in the case of *I. notabilis* in the long transects is the observed result similar to the expected result.

This lack of correspondence between the observed and expected results suggests the influence of some other, unmeasured factor responsible for the distribution of the Collembola or the possibility of an optimum moisture content of the organic layer for some species.

3.25 An investigation of the optimum core moisture contents for different Collembola

As it seemed possible, that, in the case of the moisture content of the substrate, Collembola might have an optimum preference of the type described by AGRELL (1940), further investigation appeared necessary. This type of curvi-linear relationship between Collembola and moisture would not be detected by the correlation coefficient unless the optimum was close to one of the extremes of the moisture content values found in the habitat.

In order to discover whether such an optimum existed the cores were divided into three arbitary groups according to their moisture content, dry (moisture content 50—90% of dry weight), medium (moisture content 91—130% of dry weight) and wet (moisture content over 130% of dry weight). The numbers of Collembola in each group are shown in the form of a histogram in figure 4. A second histogram is also shown in which the numbers of Collembola have been corrected for other variables with which they show a linear correlation.

The histograms illustrate that in *I. notabilis* and *Ir. plumosus* cores of medium moisture content contain the largest number of individuals. Analysis of variance showed that the numbers of both these species were significantly higher ($0.05 > p > 0.01$) in the 'medium' cores than in the 'dry' cores and, although in both cases there were larger numbers in the 'medium' cores than in the 'wet' cores, statistically significant values were approached only in *Ir. plumosus* ($0.1 > p > 0.05$). The results shown in the histograms confirm the correlation

Table 8

Square reference	Point on transect	Moisture Content (%)	Depth (mm)	Dry Weight (g × 100)	*Tullbergia krausbaueri* (Börner)	*T. callipygos* Börner	*Schaefferia willemi* (Bonet)	*Friesea mirabilis* (Tullberg)	*Anurida granaria* (Nicolet)	*Neanura muscorum* (Templeton)	*Anurophorus laricis* Nicolet	*Folsomia 4-oculata* Tullberg	*Isotomiella minor* Schäffer	*Isotoma notabilis* Schäffer	*I. olivacea* v. *neglecta* Schäffer
A7	A	60	13	605	1										
	B	103	29	748	3			1				25		33	
	C	139	25	533	2			9				2		26	
O 22	A	84	38	1796	1	2		1		1				26	
	B	133	29	627	2	1		11						17	
	C	123	29	720	5			11						26	
H 15	A	102	6	1392	11			8						35	2
	B	91	32	1111	4			1						21	2
	C	135	44	1698	9			22				1		67	
H 6	A	76	6	117							2				
	B	89	38	1649				1					1	23	2
	C	93	35	2228				3					1	6	
B 21	A	108	38	1050				1						149	
	B	107	41	2212	3			5						183	1
	C	106	35	1965				1						216	
T 8	A	138	32	961	8			7						3	
	B	120	22	579	10			5						37	
	C	194	29	475	10			5						61	
F 22	A	95	38	1100						2			2	143	3
	B	109	41	1669	1			2						178	3
	C	126	41	1926	4	1		9				3		348	
G 25	A	62	35	1701	3			2		1				25	1
	B	107	35	1522	5			9					1	66	
	C	132	44	1353				6						73	
S 19	A	102	22	749				2				1		5	
	B	167	29	507	15	1		3		1	1			25	
	C	121	44	1424								5		53	
R 20	A	101	25	812	4	2		2						2	
	B	100	44	2453	14	4		11						2	
	C	150	48	2022	13			13						14	
I 20	A	113	32	1595				1						25	
	B	94	35	1276									3	49	
	C	97	57	2290	5			9					2	123	
J 13	A	70	13	603	1										
	B	152	35	926	30			12						14	
	C	57	29	1202	10			5				7		23	
Total of species:					174	11	0	181	0	5	3	44	10	2097	14

Note: The figures for the depth of the organic layer were measured in inches so that the figures

I. olivacea v. *stachi* DENIS	*I. viridis* BOURLET	*Isotomurus plumosus* (BAGNALL)	*Tomocerus minor* LUBBOCK	*T. longicornis* MÜLLER	*Entomobrya.* sp.	*Lepidocyrtus lanuginosus* (GMELIN)	*Megalothorax minimus* WILLEM	*Sminthurides pumilis* (KRAUSBAUER)	*Sminthurinus aureus* (LUBBOCK)	*Sminthurus fuscus* (LINNÉ)	*Dicyrtoma minuta* (O. FABRICIUS)	Unidentified	Core Total	Square Total	
		2											3		SHORT TRANSECTS S. E. FACING
		7					2			1			72	135	
		15					6						60		
		1			3		20	1	10				66		
		5				2	26	1	4				69	201	
	1	4					8	4	7				66		
		59			8	2	20	4	2				151		
	1	11			1	1		12	2	1			57	355	
1	1	17			2		15	7	4	1			147		
	1									1			4		N. W. FACING
		14					1				1		43	153	
	1	93					1						106		
		158				2	7	2	8				327		
		162					11	3	10				378	987	
		49					1		15				282		
	1	4					1		5				29		
	1	13				1	13	6	4		3		93	220	
	1	10					7		4				98		
	1	19				9	14	2	2	2	1		200		LONG TRANSECTS N. E. FACING
	2	22			4	4	12	5	3	1			237	849	
	3	13				2	24	1	4				412		
	4	5				2	41	1	9				94		
	2	10					19	1	13				126	350	
	4	5				1	38	2	1				130		
		1				1	6	1	2				19		
		3				1	9	4					63	173	
		4			2	2	9	6	7				91		
	1	15				4		9	7				44		S. W. FACING
		12					6	2	7				56	183	
	1	7			2	3	15	5	6				83		
	1	25					1	1	5				59		
	3	15			1		4		16				91	318	
	2	8				1	15		2			1	168		
		2						1					4		
		4					6		3				69	136	
		11						1	6				63		
1	32	805	0	0	23	38	358	82	169	7	5	1			
												TOTAL		4060	

in the table have been converted from inches.

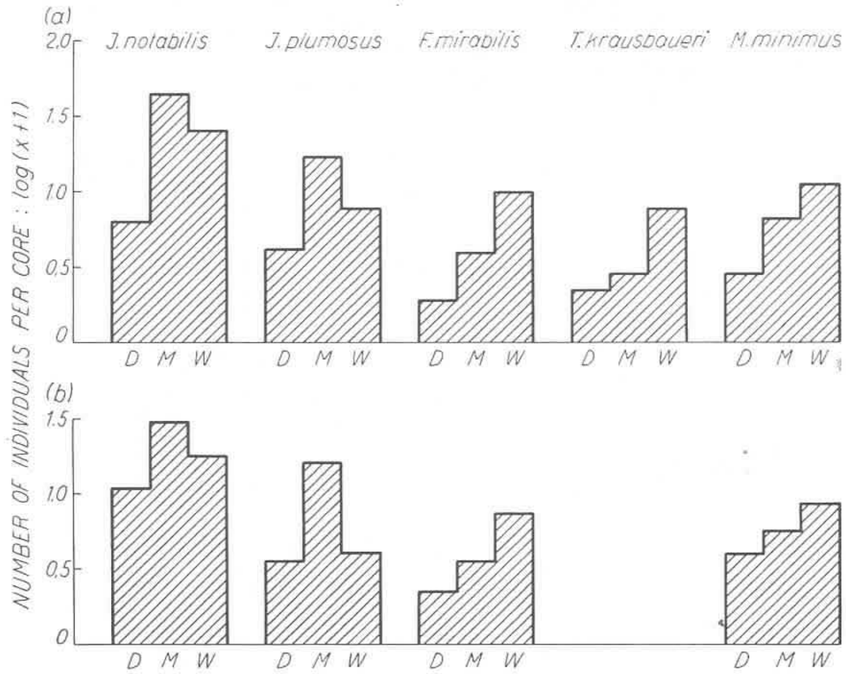

Fig. 4a. Histograms showing the numbers of Collembola found in wet, medium an dry cores. b. The same data corrected for depth (*I. notabilis*, *F. mirabilis*, *M. minimus*) or weight of the organic layer (*Ir. plumosus*). (D = Dry, M = Medium, W = Wet).

coefficients for the other three common species by also showing a linear relationship between their numbers and the moisture content.

Although both *Ir. plumosus* and *I. notabilis* appear to have an optimum moisture content of the organic layer, examination of figures 2 and 3 shows that the type of relationship demonstrated could not account for the gradients in these two species.

It can be concluded from these results that the numbers of all five species, commonly occurring in Waen Wen are related to the moisture content of the substrate, but that in *Ir. plumosus* and *I. notabilis* the relationship is curvilinear.

4 Discussion

The results of this work agree with the previous findings in the same habitat. The Collembola were again found to be aggregated and more than one species was aggregated in the same place; also, the numbers of the Collembola were again related to the depth and moisture content of the organic layer. This work has shown, however, that these physical factors alone were not responsible for the observed distribution of the Collembola and, furthermore it has been demonstrated that the Collembola are influenced by their proximity to the base of a tree and are affected by the arrangement of the surrounding trees.

Since the measured physical factors are not solely responsible, for the distribution of the Collembola it will be more profitable to consider the interpretation of the gradients in physical factors before dealing with the Collembola themselves.

4.1 Interpretations of the gradients in physical factors

Both the moisture content and the depth of the organic layer increase towards the centre of the square, but in both cases the actual amounts differ in the two types of transect. These differences cannot be explained on the basis of the different lengths of the long and

short transects (see fig. 2). The possible influence of the arrangement of the tree canopy above the sampled positions and its effect on both the amount of rainfall penetration and the amount of litter falling from the tree canopy was considered in some detail. Although it seems likely that the low moisture content at position A might be the result of the small amount of rainfall penetrating the canopy above, when all the available data were considered it was not possible adequately to explain the different patterns of depth and moisture content of the organic layer in the two types of transect on the basis of the rain penetration and litter fall from the canopy above.

4.2 Interpretations of the distribution of Collembola

The only case in which the numbers of Collembola vary in a comparable way to any measured physical factor is in the numbers of *I. notabilis* in the long transects which show a similar gradient to the depth of the organic layer. Although the other species of Collembola show correlations with the depth and moisture content of the organic layer they do not show comparable patterns of distribution. It therefore seems that the type of distribution shown by the Collembola is not, as might be expected, the result of their being correlated with either the depth or moisture content of the organic layer. The difference in length of the two types of transect is not itself responsible for the differences in the pattern of distribution of the Collembola (see figure 3) and so it seems likely that the main influence on the Collembola is the arrangement of the trees in the two types of transect.

If a single factor is responsible for the distribution of the Collembola in relation to the trees, it must be one to which the response differs in each species but it is possible that the observed distribution of Collembola results from the interaction of a number of factors including the depth and moisture content of the organic layer.

The canopy of the trees and its effect on the physical factors in the organic layer has been considered but does not appear to provide a solution to the problem of collembolan distribution and it therefore seems likely that, if the influence of the trees is direct, it is a subterranean one.

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6 Sommaire

On à procédé à une enquête, dans une plantation de sapins de Douglas (*Pseudotsuga Douglasii* Carrière) située près de Bangor, dans le pays de Galles du Nord, sur l'influence des arbres sur la distribution des Collemboles dans la couche organique du sol.

Des coupures transversales ont été faites à la base de douze arbres, et il a été démontré que la distribution des Collemboles était influencée par la disposition des arbres environnants. La profondeur, le poids et la teneur en humidité de la couche organique du sol montrérent des variations qui, elles aussi, dépendaient de la disposition des arbres environnants.

On a démontré qu'il y a un rapport entre les Collemboles et la profondeur et la teneur en humidité de la couche organique du sol, mais on ne pourrait utiliser ce rapport que pour expliquer la distribution remarquée d'une seule espèce de Collembola (*I. notabilis*) dans une sorte de disposition d'arbres seulement.

6 Summary

An investigation of the influence of the trees on the patterns of distribution of Collembola in the organic layer of the soil was carried out in a Douglas fir (*Pseudotsuga Douglasii* CARRIÈRE) plantation near Bangor, North Wales.

Transects were taken from the bases of twelve trees and the distribution of Collembola was shown to be influenced by the arrangement of the surrounding trees. The depth, weight and moisture content of the organic layer of the soil showed gradients which also depended on the arrangement of the adjacent trees.

The Collembola were shown to be related to both the depth and moisture content of the organic layer of the soil but this relationship could only be used to explain the observed distribution of one collembolan species (*I. notabilis*) in one type of tree arrangement.

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